

REMARKS/ARGUMENTS

In response to the Office Action mailed January 20, 2006, Applicant requests reconsideration. No claims are added or cancelled so that claims 1-22 remain pending.

The present patent application is directed to a method of manufacturing a semiconductor device that includes a low dielectric constant film, for example having a dielectric constant less than 2.5. The claimed method imparts to that film an improved adherence to a silicon oxide film and requires deposition of a silicon oxide film on that layer with improved adhesion.

Two independent claims are pending in this patent application, claims 1 and 9. In the method according to claim 9, an insulating film, i.e., the low dielectric constant film, is formed on a semiconductor base material. That insulating film is predominately composed of organic siloxane that also contains an organic component which is not chemically bonded to the organic siloxane. Thereafter, this insulating film is plasma treated in order to remove the organic component and, at the same time, to form a modifying layer on the surface of the insulating film. This modifying layer, as explained in the patent application, has increased adherence to a silicon oxide film. The process of claim 1 is completed by the formation of a silicon oxide film on that modifying layer. The method according to claim 9 is similar to the method of claim 1 except there is no express requirement in the method of claim 9 that the insulating film be predominately composed of organic siloxane or contain an organic component. Rather, the insulating film is described in claim 9 as being composed of organic siloxane. Thus, in the plasma treatment of claim 9 that insulating film an organic group is removed from the organic siloxane at the time that the modifying layer is formed on the surface of the insulating film. Thereafter, the silicon oxide film is formed on the modifying layer. These processes of claims 1 and 9 are fully described in the patent application from page 4 through page 10. The improvement in adhesion to silicon oxide films is reported, for example, at page 14, lines 3-5.

Claims 1 and 9, as well as many dependent claims, were rejected as obvious over Aoi (U.S. Patent 6,387,824) in view of Havemann et al. (U.S. Patent 5,661,344, hereinafter Havemann). Claims 1 and 9 were also rejected as obvious over Han et al.

(Published U.S. Patent Application 2002/0102413, hereinafter Han) in view of Havemann. Both rejections are respectfully traversed. If the independent claims 1 and 9 are patentable with respect to both rejections, then clearly all pending claims are patentable, although a tertiary reference was cited in rejecting claims 18, 19, 21, and 22.

As best understood, in rejecting claim 1 the Examiner seems to have placed emphasis on the process illustrated in Figures 4(a)-4(c) of Aoi. The jumbled description of the application of Aoi in the rejection of a large number of different claims makes complete understanding of the basis of the rejection more difficult than if the rejection had been set out in a more conventional form. According to Aoi, organic films 21 and 22 are sequentially deposited on a substrate 20 and, after the formation of a contact hole 23 and a wire groove 24 in the respective films, the films are subjected to a plasma treatment. The Examiner presumes that this plasma treatment would have the effect described in both of claims 1 and 9, i.e., removal of an organic component from a principally siloxane layer and the removal of an organic group from a siloxane layer. However, there is no evidence in Aoi to support the assertion that such a result would be achieved in Aoi's embodiment 6.

Further, the Examiner assumes, without any evidence from Aoi, that a modifying layer would be formed on the surface of an insulating film. If it is assumed that the insulating film referred to in the rejection is layer 22 of Aoi, then there is no modifying layer formed as part of that layer and at the surface of that layer. Rather, according to Aoi, the entire organic-inorganic hybrid film 22 is transformed into a different layer 26 having a lower dielectric constant than the dielectric constant of the layer 22. There is no description of conversion of only part of any layer into a different layer, i.e., the modifying layer of claims 1 and 9, and, most particularly, no description of any change in the adhesion properties of any layer is found in Aoi. Rather, all that is described in Aoi is conversion of an entire layer to a lower dielectric constant layer by increasing the porosity of the layer 22. Thus, Aoi fails to supply the proposition for which it was cited in the rejection.

In the final rejection, the Examiner acknowledged that there is no description in Aoi of depositing a silicon oxide film on any film that has been plasma treated. The

absence of such a step resulted in the retraction of the previous rejection for anticipation and the citation of Havemann as allegedly suggesting a modification of Aoi by adding deposition of a silicon oxide film. However, nothing in Aoi nor Havemann would lead a person of skill in the art to add a silicon oxide film to the structure shown in either of Figures 4(b) and 4(c) in Aoi. In fact, the material deposited on the films in Aoi is not a silicon oxide film at all but rather a copper wiring layer 27 that fills the openings formed in the two dielectric layers 21 and 22, layers which become layers 25 and 26 in Aoi's Figure 4(c).

No specific part of Havemann was cited as supporting the rejection. Rather, Havemann was cited as describing the fabrication of devices "using standard dielectric of a conventional process". In this process, a capping layer is deposited on a porous film. However, there is no consideration given to a treatment of the porous film before depositing the capping layer or to whether the capping layer deposited has good or poor adhesion to the underlying porous film. No techniques for improving any adhesion between the capping film and the porous film are ever described or even alluded to in Havemann. Therefore, there is no suggestion in the references for modification of Aoi with Havemann that could suggest the invention as defined by claim 1 and its dependent claims 2-8, 17, and 19. For these reasons, upon reconsideration, the first of the two rejections should be withdrawn.

Han, like Aoi, describes the formation of a low dielectric constant film. The low dielectric film is cured with a plasma treatment. According to Han, the films prepared according to his disclosure have improved elastic modulus, reduced dielectric constant, improved thermal stability, improved outgassing characteristics, and superior integration properties due to curing. Nowhere in this list of advantages is there any discussion or reference to improved adhesion to subsequently deposited silicon oxide films.

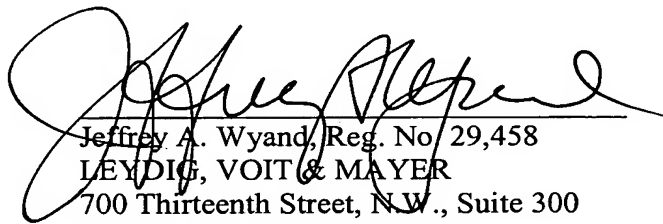
As in Aoi and as acknowledged in the Office Action, there is no description in Han of depositing a silicon oxide film on the plasma-cured low dielectric film described by Han. Again, reliance was placed upon Havemann as allegedly suggesting a modification of Han to produce the claimed invention. However, for the same reasons already presented with respect to the first rejection, there is no suggestion in the prior art

for modifying Han with Havemann. Rather, the only basis for asserting that such a modification would have been obvious is knowledge of the invention itself, a prohibited basis for rejecting a claim as obvious. Moreover, with respect to the second rejection, Han provides no teaching for plasma treatment of a completely formed film. Rather, the plasma treatment in Han is part of the film formation process itself since "curing" is intended to complete that process, according to Han, not to provide a modified surface portion of a low dielectric film like the modifying layer of claims 1 and 9. For both of these reasons, upon reconsideration, the rejection of claims 1 and 9, based upon the asserted modification of Han with Havemann, should be withdrawn.

While, at this time, no arguments are presented with respect to the rejections of the dependent claims, Applicant reserves the right to make additional arguments with regard to the rejection of the dependent claims in the event of an appeal of the final rejection.

Reconsideration and allowance of all claims 1-22 are earnestly solicited.

Respectfully submitted,



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